X. ON-BOARD SYSTEMS: ATRC RESEARCH PLAN

After four winters of snowplow guidance research, the ATRC'S survey of the TAC members and stakeholders resolved what new research would be the most valuable for ADOT after the end of the joint ASP evaluation program with California. As described earlier in Chapter V, the TAC survey results (Appendix J) mandated that commercial on-board driver-warning systems would be the new focus of an operational evaluation program in Phase Three.

RESEARCH ACTIVITIES FOR YEAR FIVE

The project TAC members and partner districts played a key role in determining the nature of the Phase Three research activities for 2002-03. Each district was asked to determine where the new systems could best be employed in their area of operations, and, to select a snowplow for the testing program. The only constraint was that all the plow trucks should be late-model Macks, similar to F342, the existing ADOT-3M advanced snowplow.

As detailed earlier in Chapter V, the results of the TAC survey directed the ATRC to conduct operational testing of three Bendix XVision units along the I-40 corridor in the 2002-03 winter. Additional Eaton VORAD collision warning radar systems were also acquired for evaluation at four other regional sites (see map, Figure 7, and Table 4).

Phase Three would be the first winter for ADOT to perform this snowplow research at the local rather than the regional level. The districts had to consider many factors in assigning radar or night vision to their local forces, such as the roadway classification, traffic volume, winter storm frequency, and total snowfall. Each district also had to consider the project's operational evaluation needs, which called for utilizing a variety of roadways, terrains and storm histories. There were several internal ADOT factors to consider in every case, including local plow truck route assignments, attitudes of the snowplow drivers on those routes, and perspectives of the local maintenance Org supervisors.

Org-Centered Research Plan

The ATRC's plan for Phase Three of the advanced snowplow research project was relatively simple and straightforward, especially compared to the complex procurement, construction, and joint agency partnering activities of the past four winters. This final Year Five of the project required a new approach at a different level of the ADOT organization. Additionally, it called for extensive coordination with the individual vehicle system suppliers.

With the new focus on self-contained on-board warning systems, and once the research vehicle assignments had been made, the key level of active participation for the project was no longer at the District level, but at the local maintenance Organizations, or Orgs. Each of the project's seven scattered maintenance Orgs would have a warning system installed on one snowplow. The local plow operators and supervisors would, in effect, perform the research and, hopefully, would document the system issues and performance through the 2002-03 winter. Therefore, the key activities of ATRC's Year Five snowplow research program would be Org-dependent.

The project was further dependent on ADOT's Equipment Services Section, first of all, to support the procurement effort by working with established system suppliers and the ADOT

Procurement Group. Secondly, ATRC relied on the district equipment shops to both install and later to support the new systems, and the Flagstaff Shop in particular would play a key role.

System commissioning was a critical issue for both on-board warning systems. ATRC, with TAC guidance, determined that all of the system installations should be performed at one location by one experienced team of technicians. The complexity of the installations and the variations between plow trucks required that one shop team should perform all system installations and calibrations. This role fell to the Flagstaff Shop, both for its prior experience with the Caltrans ASP and for its key role in developing the ADOT-3M advanced snowplow.

In the earlier winters of the project, the Caltrans plow had required frequent service in Flagstaff for numerous truck and ASP system maladies, including CWS radar problems. More recently, the ADOT-3M Advanced Snowplow F342 had been completely equipped in Flagstaff with the standard EVT-300 radar unit, with an Automatic Vehicle Location (AVL) tracking system, and with the complete 3M Lane Awareness System.

Figure 22. Installation of Vehicle Systems at Flagstaff Shop

There was no question that the Flagstaff Shop had the expertise for the new program, and the staff there was totally willing to support the new program. To ensure efficient future local support, as the system installations progressed in Flagstaff, equipment shop staff from the other partner districts also assisted with the work to commission their own plow trucks.

ATRC Shift Activity Reports

In the four previous winters of the advanced snowplow project, ATRC had collaborated with the Caltrans team, and later with 3M staff, to collect and share consistent research data and results. This meant utilizing a variety of report forms and survey questionnaires that would not only meet

the data needs of the larger agency and industry research programs, but would support further ADOT research information needs and goals as well.

ATRC had developed its own driver survey forms for the side-by-side evaluations of the ADOT-3M plow, based primarily on the Caltrans program. The evaluation records for both systems could be shared and each party could extract and interpret the information that was significant to them. The project had also shared its driver survey results with 3M and the University of Iowa (U of I). ATRC utilized the results of the 3M surveys that had been conducted by the U of I, but did not attempt further interpretation of that data, as described in the project's Phase Two report.

In the four prior years, ATRC also developed a shift activity report that focused on operational evaluations of the ASP systems, rather than on the operator training activities. Only the Team Leader drivers utilized these shift reports. The key information requested of the drivers included road surface condition, weather, visibility, mileage, and system status. These shift reports were continually streamlined to reduce the paperwork effort for the operators at the end of a long shift of plowing in severe storm conditions and heavy traffic. For Year Five, the format and content of the shift activity reports were again reviewed and edited, and they were provided to the crews of the several new snowplows that were just joining the research program (Appendix E).

Incident Reports

While shift activity reports were basic to evaluating the operational performance of the on-board systems, a second type of information in more depth was also needed. This was an incident or event report form, intended to document any unusual situation where the radar or night vision system either helped or hindered the snowplowing operation. This form (Appendix F) asked for time and place information, a description of the event, and the outcome. This event record form was originally provided by Bendix to gather performance data for its XVision rollout, but the form was also adapted by ATRC to collect the same information for the CWS radar.

The already-burdened drivers were not expected to fill out an event report daily, but it was hoped that they would have reasonably frequent incidents and comments regarding the effectiveness of the systems. ATRC and the TAC sought both positive and negative anecdotal reports in this manner. As with many things, an "event" was subject to local interpretation over the winter.

Driver Surveys

Based on ADOT experience, no research activity in the snowplowing arena could be complete without administering driver opinion surveys. For Phase Three, with no outside partner actively involved in the evaluation, the ATRC administered several driver surveys (Appendixes G & H) at intervals through the winter season. This approach maintained the continuity of processes and expectations, but it also provided an excellent perspective of the drivers' reactions to each system as it was commissioned, and as it performed over time through the mild 2002-03 winter season.

The ATRC's extensive use of these surveys was quite productive. The surveys were developed from the resources of prior winters, but with a focus solely on the issues of greatest concern for the project TAC members and for ATRC. The survey addressed driver level of acceptance, likes and dislikes, perceived benefits, and driver recommendations. Over the initial winter deployment of the two on-board systems, these surveys revealed clear trends with regard to many aspects of the systems, and to the overall level of acceptance by the drivers. They also revealed a wide range of reactions to, and perceived needs for, these systems.

ATRC planned to conduct the surveys upon system introduction, at mid-season, and after the 2002-03 winter was over. This plan was followed, but the radar units were not commissioned until mid-winter. Therefore the XVision crews filled out three surveys at two-month intervals, but the CWS radar drivers took the survey only twice. Survey results for each system are discussed later in this section, and the full summaries are included as Appendixes G and H.

Ride-Alongs

The Phase Three research effort was completely decentralized in comparison with the previous winters, and the results would depend on coordination and follow-up at the local level. The ATRC workplan for the winter involved frequent staff contacts with the Org supervisors and the snowplow drivers, including visits to each local maintenance yard as time and weather would permit. This plan was reasonably successful, although the relatively mild winter reduced the opportunities to observe and document storm performance and to get real-time driver feedback.

One key aspect was "ride-along activity" by ATRC staff. This was intended to observe system performance and to engage the drivers in more discussion than the report forms could provide. ATRC staff ride-alongs this winter were limited to Little Antelope and Gray Mountain, but there were field visits to all of the project Orgs in support of the driver surveys, for storm debriefings, and in search of other project records.

ATRC DATA COLLECTION

By decentralizing the research activities to the field, a significant amount of data for the project also was decentralized. With seven snowplows and seven Org teams involved in the research for Year Five, new issues arose regarding consistency and thoroughness of data collection. During the winter, however, a variety of new resources, not always obvious, also were found to improve both the quality and quantity of information in support of the research process.

Fundamentally, the project was now much more exposed to the human factor, and this was especially true at the snowplow level. Of the various records needed to document the project, the daily shift reports and the incident reports were the most burdensome for some of the drivers. While most Orgs submitted good records, even the most consistent sources had shortfalls during severe storm periods. The results, and issues, are discussed in a later section of this report.

As mentioned above, ATRC staff conducted some snowplow ride-alongs as well as numerous visits to the field sites to discuss progress with drivers and supervisors. These meetings and driver feedback were very useful in filling in the gaps in activity and event reporting. With regard to the most basic operational data, however, more probing would be required.

ATRC eventually found that the shift reports were not complete enough to recreate the overall history of the 2002-03 winter for the project, as intended. Other resources existed, and it had been expected that those sources of information would be needed to confirm the field records. The only change in plan was that ATRC was obligated to rely on regional, not local, records to put together a complete overview of the winter season and the project snowplow activities.

Supplemental Data Resources

Because many of the shift activity reports were not always consistently completed and turned in, ATRC then resorted to the statewide central maintenance reporting system called PECOS. It was

determined that the snowplow operators always filled out their vehicle logbooks and the maintenance record worksheets before going home from even the most arduous shift, but often the ATRC shift reports would be deferred and/or eventually lost.

Fortunately, ADOT's PECOS system captures the key maintenance activity information for each shift, including the operators' names, work shift hours, odometer readings, routes patrolled, and any noteworthy system problems. PECOS is sorted by activity code, and for snowplowing there are only a few key categories to be reviewed. These various task codes include plowing snow, applying abrasives or deicers, winter storm patrol, storm and rock patrol, and spot ice control. PECOS records also list manhours, equipment hours, materials quantities, and distance traveled.

ATRC found that once given on-line access to the PECOS logs, all records for specific activities and routes could be searched, identified and printed for review. Where gaps or overlaps were found in reviewing these records, the drivers' handwritten data entry sheets were also stored at the Orgs and could be crosschecked for specific dates.

This information filled many of the data gaps from the activity reports; it identified all days of plowing activity, and summarized the miles when the on-board systems were potentially in use. However, there were some areas of data that required follow-up, for example, the system reports did not isolate miles driven and other performance data for the project snowplows from the other trucks active on the same route during a storm shift.

The ATRC retrieved and reviewed all PECOS electronic work records for each project plow vehicle, but it was still necessary to visit each of the maintenance camps to review their hand-written records. This was also an opportunity to interview drivers and supervisors about their experiences over the winter.

A further information gap in the shift reports was the winter storm history, but with in-depth TAC support from the National Weather Service (NWS), this information also could be recovered. The ATRC met with NWS staff to identify the weather recording station that was most relevant to each of the seven project plow routes, and those observation records were copied from the regional office files at Bellemont, Arizona, near Flagstaff. As a result, ATRC was able to match the NWS winter storm date and snowfall records with the PECOS plowing activity records, working forward from the commissioning date for each of the seven project snowplows.

The results of these ATRC data recovery efforts are included in Appendixes A, B, C, and D, and the relevant storm history information is referenced throughout this report.